

---

*Final*

# **Sitewide Groundwater Performance Monitoring Plan**

**Bayer CropScience Institute  
Facility, Institute, West Virginia**

Prepared for  
**Union Carbide Corporation**

Revised November 2014

**CH2MHILL®**



# Contents

---

Section	Page
<b>Acronyms and Abbreviations .....</b>	<b>v</b>
<b>1 Introduction .....</b>	<b>1-1</b>
1.1 Main Chemical Plant Monitoring Well Network Update .....	1-1
1.2 Data Evaluation Procedure Update .....	1-1
1.3 Inclusion of WWTU Area in Groundwater Monitoring Program .....	1-2
1.4 Overview of Sitewide Groundwater Strategy .....	1-2
<b>2 Groundwater Monitoring.....</b>	<b>2-1</b>
2.1 Groundwater Monitoring Frequency.....	2-1
2.2 Groundwater Elevation Measurements.....	2-1
2.3 Groundwater Sampling .....	2-1
2.3.1 Main Chemical Plant Groundwater Sampling Well Network .....	2-1
2.3.2 WWTU Area Groundwater Sampling Well Network .....	2-2
2.3.3 Groundwater Sampling Method .....	2-2
2.3.4 Target Analyte Lists.....	2-2
<b>3 Data Evaluation.....</b>	<b>3-1</b>
3.1 Groundwater Elevation Evaluation .....	3-1
3.2 Groundwater Performance Monitoring Standard Evaluation .....	3-1
3.2.1 Performance Standard 1 Evaluation: Onsite Containment.....	3-1
3.2.2 Performance Standard 2 Evaluation: Plume Stability.....	3-2
3.2.3 Performance Standard 3 Evaluation: Reduction in COC Mass .....	3-4
3.3 Contingency Plan.....	3-4
<b>4 Compliance Reporting.....</b>	<b>4-1</b>
<b>5 References .....</b>	<b>5-1</b>

## Appendix

### A Standard Operating Procedures

#### Tables

- 1 Groundwater Monitoring Well Network
- 2 Target Analyte List
- 3 Required Analytical Method, Sample Containers, Preservation, and Holding Times
- 4 Groundwater Screening Levels
- 5 Main Chemical Plant Other Targeted COCs - Applicable Wells to Track Concentration Trends

## **Figures**

- 1 Facility Location Map
- 2 Groundwater Monitoring Network
- 3 Main Chemical Plant Thiessen Polygon Network

# Acronyms and Abbreviations

---

µg/L	micrograms per liter
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CAH	chlorinated aliphatic hydrocarbon
CCR	<i>Current Condition Report</i>
COC	constituent of concern
COV	coefficient of variation
ESL	ecological screening level
facility	Bayer CropScience facility in Institute, West Virginia
GWSL	groundwater screening level
HI	hazard index
MCL	maximum contaminant level
MDL	method detection limit
PHC	petroleum hydrocarbon
PMP	performance monitoring plan
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RSL	regional screening level
SOP	standard operating procedure
SVOC	semivolatile organic compound
UCC	Union Carbide Corporation
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WVDEP	West Virginia Department of Environmental Protection
WWTU	wastewater treatment unit



## SECTION 1

# Introduction

---

This revised *Sitewide Groundwater Performance Monitoring Plan* (PMP) has been prepared for the Union Carbide Corporation (UCC) on behalf of Bayer CropScience LP at the Bayer CropScience facility in Institute, West Virginia (hereafter referred to as the “facility”) (**Figure 1**). This PMP updates and replaces the February 2011 *Sitewide Groundwater Performance Monitoring Plan* (2011 PMP; CH2M HILL 2011a) which was approved by the U.S. Environmental Protection Agency (USEPA) on February 20, 2013.

The purpose of this revised PMP is to 1) update the monitoring well network and constituents of concern (COC) list for the main chemical plant; 2) adjust and improve the data evaluation and contingency plan procedures established in the 2011 PMP; and 3) incorporate the wastewater treatment unit (WWTU) area into the sitewide groundwater strategy and monitoring program for the facility. The following sections summarize the key changes to the PMP.

Additional site background information related to regulatory framework, sitewide groundwater strategy, proposed remedial action objectives (RAOs), and site setting can be found in documents previously submitted to USEPA, including the *Current Conditions Report* (CCR; CH2M HILL 2009), 2011 PMP (CH2M HILL 2011a), *2011 Wastewater Treatment Unit Groundwater Sampling and Evaluation* report (CH2M HILL 2012a), and the *Wastewater Treatment Unit Remedial Approach* report (CH2M HILL 2014a).

## 1.1 Main Chemical Plant Monitoring Well Network Update

This revised PMP adds four new main chemical plant monitoring wells (TW-69A, TW-70B, TW-71A, and TW-71B), which were installed and added to the monitoring program in 2011 (**Figure 2**). These wells were installed to address data gaps identified in the 2011 PMP (CH2M HILL 2011a). Main chemical plant monitoring well TW-27R was removed from the network as explained further in Section 2.3.1 below. In addition, five COCs were added to target analyte list as detailed below in Section 2.3.4.

## 1.2 Data Evaluation Procedure Update

Revisions to the 2011 PMP data evaluation processes include 1) incorporation of human health- and ecological-based site-specific screening levels into the evaluation of performance monitoring standard 1: Onsite Containment (see Section 3.2.1 below); 2) incorporation of adjusted tap water regional screening levels (RSLs) (USEPA 2014); 3) simplification of the data evaluation procedures associated with performance monitoring standard 2: Plume Stability (see Section 3.2.2 below); and 4) simplification of the contingency plan (see Section 3.3 below).

## 1.3 Inclusion of WWTU Area in Groundwater Monitoring Program

Groundwater at the WWTU area has historically been monitored quarterly to fulfill corrective action reporting requirements associated with the groundwater recovery system near former Biobasins 1 and 2 (CH2M HILL 2012a). A WWTU evaluation was completed in 2011 in accordance with the *Wastewater Treatment Unit Groundwater Evaluation* work plan (CH2M HILL 2011b). The evaluation was part of an overall effort to transfer administration of environmental corrective action activities for the WWTU area into the main facility Resource Conservation and Recovery Act (RCRA) corrective action permit. The results are summarized in the *2011 Wastewater Treatment Unit Groundwater Sampling and Evaluation Report* (CH2M HILL 2012a) and were used to characterize the current groundwater conditions, identify constituents of potential concern, evaluate the existing monitoring well network, and support an evaluation of the final groundwater remedy. Institutional controls and annual groundwater monitoring were selected as the final remedies for the WWTU area (CH2M HILL 2014a).

## 1.4 Overview of Sitewide Groundwater Strategy

The PMP is based upon the sitewide groundwater strategy for the Institute site. USEPA and the West Virginia Department of Environmental Protection (WVDEP) approved the sitewide strategy for addressing groundwater impacts at the main chemical plant in April 2010 (CH2M HILL 2011a). The strategy consists of utilizing institutional controls, focused remedies, and groundwater monitoring to meet the remedial objective for the facility. The 2011 PMP established a plan to monitor and document the performance of the sitewide groundwater strategy.

The overarching goal of the groundwater strategy is to detect and respond to changes in site conditions to prevent unacceptable human and ecological exposure to impacted groundwater. This revised PMP retains the groundwater strategy and performance monitoring standards established in the 2011 PMP, and incorporates revisions to the groundwater monitoring network and data evaluation process, including the addition of wells within the WWTU area.



# Groundwater Monitoring

---

## 2.1 Groundwater Monitoring Frequency

Groundwater elevation measurements and analytical samples will be collected annually, between October and December.

## 2.2 Groundwater Elevation Measurements

Water levels will be measured annually to confirm groundwater flow patterns at both areas of the facility. Water-level measurements will be collected from the 53 wells at the main chemical plant and the 16 wells at the WWTU (listed in **Table 1** and shown on **Figure 2**). Water-level measurements will be collected in accordance with the standard operating procedure (SOP) for groundwater level measurements (**Appendix A**). These measurements will be collected using a handheld water-level meter during a 24-hour period to the extent possible. Water-level measurements will coincide with the groundwater sampling activities described in Section 2.3; the water levels will be collected before sampling activities begin.

## 2.3 Groundwater Sampling

Groundwater analytical samples will be collected annually from facility monitoring wells to facilitate evaluation of constituent concentrations and trends in groundwater.

### 2.3.1 Main Chemical Plant Groundwater Sampling Well Network

A total of 38 main chemical plant monitoring wells will be sampled to meet the main chemical plant PMP goals (as defined in Section 3.2 below), which are categorized as follows:

- Sentinel wells: Monitor changes in COC distribution and plume stability using a series of sentinel wells.
- Perimeter wells: Monitor concentrations to determine whether dissolved COCs are migrating offsite at concentrations exceeding applicable criteria.
- Other wells: Monitor select constituents to evaluate plume stability.

All main chemical plant wells that are sampled are also part of the Thiessen well network that monitors change in dissolved COC mass at the site over time using the Thiessen polygon method. Two Thiessen monitoring well clusters (TW-69A/TW-70B and TW-71A/TW-71B) installed in accordance with the 2011 PMP were added to this revised PMP. Monitoring well TW-27R, which was originally included as part of the 2011 PMP due to historically elevated acetone concentrations noted in the area, was removed from the program. Upon further review of historical data, it was determined that the elevated acetone concentrations are generally within a perched zone shallower than 12 feet below ground surface (bgs) and that acetone concentrations are decreasing (CH2M HILL 2009). Because TW-27R is screened deeper than the perched zone and within the silt/clay semi-

confining layer (20 to 30 feet bgs), continued data collected at this location is not warranted for monitoring of the aquifer.

The main chemical plant monitoring wells and their intended purpose are listed in **Table 1** and shown on **Figure 2**.

### **2.3.2 WWTU Area Groundwater Sampling Well Network**

Groundwater monitoring will be completed to evaluate whether there are any changes in concentrations that would have the potential to create new exposures and to monitor onsite constituent concentrations that were above generic screening levels in the past (CH2M HILL 2014a).

Seven monitoring wells will be sampled to meet the PMP goals for the WWTU area (as defined in Section 3.3 below), which are categorized as follows:

- Perimeter wells: Monitor concentrations to determine whether select constituents are migrating offsite at concentrations exceeding applicable criteria.
- Other wells: Monitor select constituents to evaluate plume stability.

The WWTU area monitoring wells and their intended purpose are listed in **Table 1** and shown on **Figure 2**.

### **2.3.3 Groundwater Sampling Method**

Analytical samples will be collected using low-flow groundwater sampling techniques in accordance with the SOP for low-flow groundwater sampling and field measurements of pH, dissolved oxygen, and conductivity (**Appendix A**), or an alternate sampling approach such as passive diffusion bag sampling. Passive diffusion bag sampling is currently being evaluated and, if determined to be a viable alternate groundwater sampling technique, UCC will seek approval of this sampling approach from WVDEP and USEPA. Groundwater samples will be submitted to the laboratory in accordance with the SOP for sample handling and shipping custody (**Appendix A**). All equipment will be decontaminated in accordance with the SOP for field equipment decontamination (**Appendix A**).

### **2.3.4 Target Analyte Lists**

#### **Main Chemical Plant**

Five COCs, including 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1,3-dichlorobenzene, 2-hexanone, and diethyl ether, have been added to the target analyte list. The addition of these five COCs is the result of an investigation conducted near monitoring well cluster TW-62A/B in August 2012. Several geotechnical borings installed in the area revealed potential chemical impacts in soil. UCC collected and analyzed soil and groundwater samples in order to determine the nature and concentrations of the impacts observed at the geotechnical boring locations. The Landban guidance report (Martin 1989) confirmed that the area was used historically for several different chemical processes. The Landban report was also used to develop a list of potential COCs for the area, including an extended list of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) as well as alcohols and glycols. The five compounds listed above were not part of the original PMP COC list; because concentrations of these compounds exceeded applicable screening criteria at the August 2012 sampling locations, they were added to the revised PMP COC list.

Groundwater samples will be collected at main chemical plant monitoring wells for the site-specific VOCs listed in **Table 2**. Additionally, groundwater samples will be collected from six wells and analyzed for the site-specific SVOCs listed in **Table 2**. Monitoring wells selected for SVOC sample collection are listed in **Table 1**. The analytical methods and other laboratory-related information are summarized in **Table 3**.

### **WWTU Area**

For annual assessment purposes, the constituents evaluated in the final step of the exposure pathway screening described in the 2014 *Groundwater to Surface Water and Sediment Risk Evaluation for Metals* (CH2M HILL 2014b) will be monitored. Groundwater samples will be collected at WWTU area monitoring wells for the site-specific VOCs, SVOCs, and metals listed in **Table 2**. The analytical methods and other laboratory-related information are summarized in **Table 3**.



## SECTION 3

# Data Evaluation

---

The following sections present the methodology for evaluating groundwater elevation and analytical data for the facility.

## 3.1 Groundwater Elevation Evaluation

Groundwater-level data will be used to prepare a groundwater elevation map. Water-level data will be converted to groundwater elevations by subtracting data from surveyed reference elevations. These data will be plotted to form a contour map with a minimum contour interval of 2 feet.

Long-term trends of groundwater elevations will be assessed by evaluating current and historical groundwater elevation maps. This evaluation will include identification of the following:

- Changes in the groundwater flow directions over time; and
- Ranges and changes in groundwater elevations over time.

## 3.2 Groundwater Performance Monitoring Standard Evaluation

Laboratory analytical data collected during the annual groundwater monitoring events will be evaluated in accordance with the general concepts of the three groundwater performance monitoring standards outlined in detail in the 2011 PMP (CH2M HILL 2011a). A summary of these performance standards is provided below.

- **Onsite containment of COCs:** Ensures that groundwater containing COCs at concentrations that exceed applicable risk-based criteria does not migrate offsite.
- **Stability of COC plumes:** Ensures the groundwater COC plumes onsite are stable or decreasing in size and are not migrating into areas of the facility where they could result in potential unacceptable risk to human receptors.
- **Reduction in COC mass over time:** Ensures groundwater quality continues to improve over time as measured by a reduction in the COC mass dissolved in groundwater. This performance standard only applies to the main chemical plant monitoring wells.

The performance standards outlined in Sections 3.2.1 through 3.2.3 below represent the revised data evaluation procedures. Additional background information on the development of the original groundwater performance monitoring standards is included in the 2011 PMP (CH2M HILL 2011a).

### 3.2.1 Performance Standard 1 Evaluation: Onsite Containment

The evaluation process for the onsite containment groundwater performance standard includes comparing groundwater COCs in perimeter monitoring wells to risk-based criteria,

as described below. To screen potential risk for human exposure to groundwater, data from nine perimeter monitoring wells adjacent to property boundaries will be compared to the most recent USEPA maximum contaminant levels (MCLs) (USEPA 2009a). If no MCL exists, the data will be compared to the most recent version of the RSLs (EPA 2014) based on a target cancer risk equal to  $1\text{E-}06$  and an adjusted target non-cancer hazard index (HI) of 0.1. The target non-cancer HI was adjusted to account for the potential of cumulative effects on the body. Perimeter wells are identified in **Table 1** and shown on **Figure 2**; MCLs and RSLs are listed in **Table 4**.

In addition, 16 perimeter monitoring wells adjacent to the Kanawha River will be compared to site-specific groundwater screening levels (hereafter referred to as site-specific GWSLs) protective of Kanawha River exposure pathways for both human and ecological receptors. These site-specific GWSLs were developed in the *Groundwater to Surface Water Screening Level and Risk Evaluation* (CH2M HILL 2012b) to evaluate groundwater discharging to the Kanawha River.

Site-specific GWSLs were developed for compounds detected at the facility that exceeded the USEPA Region 3 Biological Technical Assistance Group (BTAG) ecological screening levels (ESLs) (USEPA 2006). The site-specific GWSLs are based on the most protective levels available for human health and ecological receptors. The ecological levels were identified as the site-specific GWSLs for COCs with the exception of bis(2-chloroethyl)ether, which was based on human health levels. The BTAG ESLs will be used as the screening level for COCs where GWSLs were not developed. If BTAG ESLs are exceeded for COCs without GWSLs in the future, a site-specific GWSL will be developed by the same method used in the *Groundwater to Surface Water Screening Level and Risk Evaluation* (CH2M HILL 2012b). Perimeter wells adjacent to the Kanawha River are identified in **Table 1** and shown on **Figure 2**; site-specific GWSLs are listed in **Table 4**.

The onsite containment groundwater performance standard is met if COC concentrations in the perimeter monitoring wells are either 1) below risk-based criteria, or 2) exhibit stable or decreasing concentration trends where no offsite impact is demonstrated (e.g., via pore water sampling) or offsite impact is in control (e.g., via institutional controls).

### 3.2.2 Performance Standard 2 Evaluation: Plume Stability

The groundwater performance metric for plume stability will be evaluated using the Mann-Kendall non-parametric statistical test (Gilbert 1987). This test evaluates whether COC concentrations in groundwater are statistically increasing or decreasing. Groundwater concentration trend analysis will be performed at all 38 monitoring wells at the main chemical plant sampled annually for four key groundwater COC groups or COCs, including:

- **Chlorinated aliphatic hydrocarbons (CAHs).** This COC group includes tetrachloroethene, trichloroethene, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,2-trichloroethene, cis-1,2-dichloroethene, and vinyl chloride.
- **Petroleum Hydrocarbons (PHCs).** This COC group includes benzene, ethylbenzene, toluene, xylenes, and naphthalene.
- **Carbon Tetrachloride**

- **Chloroform**

In addition, several other main chemical plant groundwater COCs (other targeted COCs) will be evaluated on a well-by-well basis because of their potential for unacceptable risk to human health or the environment coupled with their isolated or irregular occurrence onsite. The other targeted COCs include 1,4-dioxane, dichlorodifluoromethane, trichlorofluoromethane, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, and phenol. The monitoring wells to be evaluated for one or more targeted COC are listed in **Table 5**.

Groundwater concentration trend analysis will also be performed at all seven monitoring wells at the WWTU sampled annually for each constituent listed below:

- VOCs (1,4-dioxane, benzene, tetrachloroethene, trichloroethylene, trichlorofluoromethane, and vinyl chloride);
- SVOCs (bis[2-chloroethyl]ether); and
- Dissolved metals (beryllium, cadmium, cobalt, lead, and manganese).

Mann-Kendall statistical tests will be performed using analytical data collected during the groundwater monitoring event as well as historical data. The Mann-Kendall data set will span over a period of up to 8 years and will not include data collected before 2008. Samples exhibiting concentrations below the method detection limit (MDL) will be assigned a common value lower than the detected measurements for the trend analysis. Data reported as trace or less than the detection limit can be used in the Mann-Kendall test by assigning them a common value that is less than the smallest measured value in the data set (Gilbert 1987). A common value will be selected from each COC group data set that will be slightly lower than the lowest MDL concentration within the data set. For example, if the lowest MDL concentration is 0.125 microgram per liter ( $\mu\text{g/L}$ ), a common value of 0.1  $\mu\text{g/L}$  would be assigned to the data set for all nondetect results.

A significance level of 0.1 to 0.05 (i.e., 90 to 95 percent confidence) will be used in the Mann-Kendall tests and interpreted using the following guiding principles:

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.

For monitoring wells where no trend can be statistically determined at the 90 percent confidence level, concentrations will be deemed stable if the coefficient of variation (COV) is less than one. The COV is a statistical measure of how the individual data points vary about the mean value and is defined as the standard deviation divided by the sample mean (USEPA 2009b). The COV is a relative measure of variation in the groundwater concentration data.

A Mann-Kendall result will only be reported for wells with at least six sampling events and a detection frequency greater than 50 percent. The performance standards for stable or decreasing groundwater COC plumes are as follows:

If more than 90 percent of the wells exhibit stable or decreasing concentrations of COCs, then the standard is achieved.

If all sentinel wells exhibit stable or decreasing concentrations of COCs, then the standard is achieved.

### **3.2.3 Performance Standard 3 Evaluation: Reduction in COC Mass**

The Thiessen polygon method (USEPA 1998) was selected to assess and document the sitewide total dissolved mass of COCs in the aquifer at the main chemical plant, as developed in the 2011 PMP (CH2M HILL 2011a). There are no Thiessen polygons defined at the WWTU portion of the facility because of the low concentrations and low contaminant mass. The Thiessen polygon method is a spatially integrated approach that uses sitewide mass estimates of key COCs to evaluate changes in plume mass over time. The distribution of the Thiessen polygons is shown on **Figure 3**.

A non-parametric trend analysis of groundwater COC mass, similar to the Mann-Kendall test described in Section 3.2.2, will be performed for each of the four key COC grouping (CAHs, PHCs, carbon tetrachloride, and chloroform) using the Thiessen polygon method (CH2M HILL 2011a).

The performance standard is achieved if a reduction in groundwater COC mass is measured for each key COC grouping at the facility, or if the COC mass reaches asymptotic conditions after exhibiting a decrease over time.

## **3.3 Contingency Plan**

If the performance metrics for any of the performance standards are not met, a phased contingency plan will be triggered that consists of the following steps:

1. Determine if the condition could result in a potential unacceptable exposure. Applicable pathways will be evaluated, such as vapor intrusion, drinking water, ecological impacts to surface water, etc.
2. If the metric does not create an unacceptable potential exposure, then monitoring will continue in accordance with this plan and the result will be noted in the annual compliance report.

If the metric results in the potential for an unacceptable exposure to human health or the environment, UCC will contact USEPA to discuss the appropriate path forward to address the risk. This may include evaluating available site data to determine the cause for the observed excursion from the metric; collecting additional data, if appropriate, to assess site conditions and the need for mitigation; or implementing a focused remedy to manage unacceptable risk and achieve the RAOs for the facility. The excursion and steps taken to mitigate the excursion will be documented in the annual compliance report.



## SECTION 4

# Compliance Reporting

---

A groundwater performance monitoring report will be prepared and submitted to USEPA annually within 6 months following each annual groundwater sampling event. This report will include the following:

- Tabulated groundwater elevation data;
- Potentiometric surface maps (one for the main chemical plant and one for the WWTU area);
- Tabulated analytical data compared to applicable screening levels;
- Summary of focused remedies implemented at the facility;
- Discussion of the evaluation of the performance monitoring standards, including key graphics to convey trends (e.g., trend graphs, mass plots); and
- Recommendations on a path forward if the performance monitoring metrics are not met.



## SECTION 5

# References

---

- CH2M HILL. 2009. *Current Conditions Report*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. October.
- CH2M HILL. 2011a. *Sitewide Groundwater Performance Monitoring Plan*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. February.
- CH2M HILL. 2011b. *Wastewater Treatment Unit Evaluation*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. April.
- CH2M HILL. 2012a. *2011 Wastewater Treatment Unit Groundwater Sampling and Evaluation Report*. Prepared for Union Carbide Corporation. November.
- CH2M HILL. 2012b. *Groundwater to Surface Water Screening Level and Risk Evaluation*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. November.
- CH2M HILL. 2014a. *Wastewater Treatment Unit (WWTU) Remedial Approach*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. September.
- CH2M HILL. 2014b. *Groundwater to Surface Water and Sediment Risk Evaluation for Metals*. Bayer CropScience Institute Facility. Prepared for Union Carbide Corporation. February.
- Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. Wiley, New York.
- Martin, Nathan B. 1989. *Landban Guidance. Process Activities and Chemical Listings*. Union Carbide Corporation, Institute Plant, Institute, West Virginia. October.
- U.S. Environmental Protection Agency (USEPA). 1998. *Monitoring and Assessment of In Situ Biocontainment of Petroleum Contaminated Ground-Water Plumes*. EPA/600/R-98/020. Office of Research and Development, Washington DC. February.
- U.S. Environmental Protection Agency (USEPA). 2006. *Freshwater Screening Benchmarks, Region III Biological Technical Assistance Group (BTAG)*. July.
- U.S. Environmental Protection Agency (USEPA). 2009a. *National Recommended Water Quality Criteria*. <http://epa.gov/criteria/wqctable/>
- U.S. Environmental Protection Agency (USEPA). 2009b. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance*. EPA-530-R-09-007. Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency. March.
- U.S. Environmental Protection Agency (USEPA). 2014. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. May.



## Tables

---



TABLE 1  
Groundwater Monitoring Well Network  
Revised Sitewide Groundwater Performance Monitoring Plan  
Bayer CropScience Institute Facility  
Institute, West Virginia

Well ID	Screened Lithology	Shallow or Deep Aquifer Zone <sup>a</sup>	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Annual Monitoring Event Activity	Analytical Suites <sup>b</sup>			Sentinel or Perimeter Monitoring Well	Part of Thiessen Network
						Site- Specific VOC List	Site- Specific SVOC List	Site-Specific Dissolved Metals List		
Main Chemical Plant Area Monitoring Wells										
ENBN-14	Alluvial Aquifer	Deep	36	38	Sample+Water Level	X				X
MW-102	Alluvial Aquifer	Shallow	23	33	Sample+Water Level	X	X		Perimeter - River	X
MW-103	Alluvial Aquifer	Deep	41	51	Sample+Water Level	X	X		Perimeter - River	X
MW-104	Alluvial Aquifer	Shallow	NA	34*	Water Level					
TW-24	Alluvial Aquifer	Shallow	16	26	Water Level					
TW-26	Alluvial Aquifer	Shallow	16	26	Sample+Water Level	X			Sentinel	X
TW-29	Alluvial Aquifer	Shallow	19	29	Water Level					
TW-42	Alluvial Aquifer	Deep	43	53	Sample+Water Level	X				X
TW-45	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X				X
TW-46	Alluvial Aquifer	Deep	34	44	Sample+Water Level	X				X
TW-51	Alluvial Aquifer	Shallow	9	19	Water Level					
TW-52A	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X	X		Sentinel	X
TW-52B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X	X		Sentinel	X
TW-53	Alluvial Aquifer	Deep	36	46	Sample+Water Level	X			Sentinel	X
TW-54A	Alluvial Aquifer	Shallow	25	35	Sample+Water Level	X				X
TW-54B	Alluvial Aquifer	Deep	43	53	Sample+Water Level	X				X
TW-55	Alluvial Aquifer	Deep	30	40	Sample+Water Level	X				X
TW-56	Alluvial Aquifer	Deep	50	60	Sample+Water Level	X				X
TW-57	Alluvial Aquifer	Deep	35	45	Sample+Water Level	X				X
TW-58	Alluvial Aquifer	Shallow	15	25	Sample+Water Level	X			Sentinel	X
TW-59A	Alluvial Aquifer	Shallow	18	28	Sample+Water Level	X				X
TW-59B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X				X
TW-60A	Alluvial Aquifer	Shallow	16	26	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-60B	Alluvial Aquifer	Deep	32	42	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-61	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X			Sentinel	X
TW-62A	Alluvial Aquifer	Shallow	17	27	Sample+Water Level	X			Sentinel	X
TW-62B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X			Sentinel	X
TW-63A	Silt/Clay Unit	NA	23	33	Sample+Water Level	X	X		Perimeter - River	X
TW-63B	Alluvial Aquifer	Deep	37	47	Sample+Water Level	X	X		Perimeter - River	X
TW-64	Alluvial Aquifer	Deep	41	51	Sample+Water Level	X			Perimeter - River	X
TW-65A	Alluvial Aquifer	Shallow	15	25	Sample+Water Level	X			Perimeter - Property Boundary	X
TW-65B	Alluvial Aquifer	Deep	45	55	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-66B	Alluvial Aquifer	Deep	33	43	Sample+Water Level	X			Perimeter - River	X
TW-67B	Alluvial Aquifer	Deep	40.5	50.5	Sample+Water Level	X			Perimeter - River	X

**TABLE 1**  
Groundwater Monitoring Well Network  
Revised Sitewide Groundwater Performance Monitoring Plan  
Bayer CropScience Institute Facility  
Institute, West Virginia

Well ID	Screened Lithology	Shallow or Deep Aquifer Zone <sup>a</sup>	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Annual Monitoring Event Activity	Analytical Suites <sup>b</sup>			Sentinel or Perimeter Monitoring Well	Part of Thiessen Network
						Site- Specific VOC List	Site- Specific SVOC List	Site-Specific Dissolved Metals List		
TW-69A	Alluvial Aquifer	Shallow	20.3	30.3	Sample+Water Level	X				X
TW-70B	Alluvial Aquifer	Deep	34.2	44.2	Sample+Water Level	X				X
TW-71A	Alluvial Aquifer	Shallow	17	27	Sample+Water Level	X				X
TW-71B	Alluvial Aquifer	Deep	45	55	Sample+Water Level	X				X
VW-11A	Alluvial Aquifer	Shallow	16	26	Water Level					
VW-11B	Alluvial Aquifer	Deep	45	55	Water Level					
VW-12B	Alluvial Aquifer	Deep	43.5	53.5	Water Level					
VW-15A	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-15B	Alluvial Aquifer	Deep	39	49	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-1A	Alluvial Aquifer	Shallow	20	30	Water Level					
VW-1B	Alluvial Aquifer	Deep	33	43	Water Level					
VW-2A	Alluvial Aquifer	Shallow	10	20	Water Level					
VW-2B	Alluvial Aquifer	Deep	40	50	Water Level					
VW-3A	Alluvial Aquifer	Shallow	21	31	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-3B	Alluvial Aquifer	Deep	42	52	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-4B	Alluvial Aquifer	Deep	40	50	Water Level					
VW-7AB	Alluvial Aquifer	Shallow	20	30	Water Level					
VW-9A	Alluvial Aquifer	Shallow	18	28	Water Level					
VW-9B	Alluvial Aquifer	Deep	48	58	Water Level					
<b>WWTU Area Wells</b>										
VW-16B	Alluvial Aquifer	Deep	46.33	56.33	Water Level					
VW-20A	Alluvial Aquifer	Shallow	22.09	32.09	Sample+Water Level	x	x	x		
VW-20B	Alluvial Aquifer	Deep	41.13	51.13	Water Level					
W-1B	Alluvial Aquifer	Deep	34.30	49.30	Water Level					
W-2A	Alluvial Aquifer	Deep	33.40	53.40	Sample+Water Level	x	x	x	Perimeter - River	
W-3	Silt/Clay Unit	NA	21.10	37.10	Sample+Water Level	x	x	x	Perimeter - River	
W-3A	Alluvial Aquifer	Deep	36.87	56.87	Water Level					
W-5	Silt/Clay Unit	NA	21.35	36.35	Sample+Water Level	x	x	x	Perimeter - River	
W-5A	Alluvial Aquifer	Deep	35.63	52.30	Sample+Water Level	x	x	x	Perimeter - River	
W-6B	Alluvial Aquifer	Deep	37.70	52.70	Water Level					
W-7A	Alluvial Aquifer	Deep	36.40	50.40	Water Level					
W-8	Alluvial Aquifer	Deep	10.00	30.00	Water Level					
W-10A	Alluvial Aquifer	Deep	33.38	50.80	Sample+Water Level	x	x	x	Perimeter - Property Boundary	
W-11A	Alluvial Aquifer	Deep	33.00	53.00	Water Level					
W-13A	Alluvial Aquifer	Deep	29.85	49.85	Water Level					
W-14	Silt/Clay Unit	NA	13.60	33.60	Sample+Water Level	x	x	x	Perimeter - River	

**Notes:**

bgs = below ground surface

NA = not applicable

WWTU = Wastewater Treatment Unit

<sup>a</sup> Screened zones: Shallow = <30 ft-bgs; Deep = >30 ft-bgs

<sup>b</sup> See Table 2 for site-specific lists of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs).

\* Based on measured total depth.



TABLE 2

## Target Analyte List

Revised Sitewide Groundwater Performance Monitoring Plan

Bayer CropScience Institute Facility

Institute, West Virginia

Constituent Group	Target Analyte List	Main Chemical Plant Area	WWTU Area
VOCs	1,1,2,2-Tetrachloroethane	x	
VOCs	1,1,2-Trichloroethane	x	
VOCs	1,1-Dichloroethane	x	
VOCs	1,1-Dichloroethene	x	
VOCs	1,2,4-Trimethylbenzene	x	
VOCs	1,2-Dichloroethane	x	
VOCs	1,2-Dichloropropane	x	
VOCs	1,3,5-Trimethylbenzene	x	
VOCs	1,3-Dichlorobenzene	x	
VOCs	1,4-Dichlorobenzene	x	
VOCs	2-Butanone	x	
VOCs	2-Hexanone	x	
VOCs	4-Methyl-2-Pentanone	x	
VOCs	Acetone	x	
VOCs	Benzene	x	x
VOCs	Bromodichloromethane	x	
VOCs	Bromomethane	x	
VOCs	Carbon Disulfide	x	
VOCs	Carbon tetrachloride	x	
VOCs	Chlorobenzene	x	
VOCs	Chloroform	x	
VOCs	Chloromethane	x	
VOCs	cis-1,2-Dichloroethene	x	
VOCs	Dibromochloromethane	x	
VOCs	Dichlorodifluoromethane	x	
VOCs	Diethyl ether	x	
VOCs	Ethylbenzene	x	
VOCs	Methylene chloride	x	
VOCs	Naphthalene	x	
VOCs	Styrene	x	
VOCs	Tetrachloroethene	x	x
VOCs	Toluene	x	
VOCs	trans-1,2-Dichloroethene	x	
VOCs	Trichloroethene	x	x
VOCs	Trichlorofluoromethane	x	x
VOCs	Vinyl chloride	x	x
VOCs	Xylenes	x	
SVOCs	1,4-Dioxane	x	x
SVOCs	2-Methylnaphthalene	x	
SVOCs	Benzo(b)fluoranthene	x	
SVOCs	bis(2-Chloroethyl)ether	x	x
SVOCs	bis(2-Chloroisopropyl)ether	x	
SVOCs	bis(2-Ethylhexyl)phthalate	x	
SVOCs	Hexachloroethane	x	
SVOCs	Isophorone	x	
SVOCs	Naphthalene	x	
SVOCs	Phenol	x	
Metals	Beryllium, dissolved		x
Metals	Cadmium, dissolved		x
Metals	Cobalt, dissolved		x
Metals	Lead, dissolved		x
Metals	Manganese, dissolved		x

**Notes:**

VOC = volatile organic compound

SVOC = semivolatile organic compound

WWTU = Wastewater Treatment Unit

TABLE 3

Required Analytical Method, Sample Containers, Preservation, and Holding Times

Revised Sitewide Groundwater Performance Monitoring Plan

Bayer CropScience Institute Facility

Institute, West Virginia

Analyses	Preparatory/Analytical			Quantity	Preservative <sup>c</sup>	Holding Time <sup>d</sup>
	Method	Sample Matrix <sup>a</sup>	Container <sup>b</sup>			
Volatile Organic Compounds	SW8260B	W	40-mL, glass	3	HCl, pH<2, cool to 4°C	14 days
Semivolatile Organic Compounds	SW8270C-Ultra Low	W	1-L, amber glass	2	cool to 4°C	7 days - extract 40 days - analyze
Dissolved Metals*	6010B/6020/7470A	W	500-mL polyethylene	1	HNO <sub>3</sub> to pH<2; Cool to 4°C	180 days

Source: USEPA SW-846, third edition, Update IV (January 2008).

## Notes:

Sample containers and volume requirements will be specified by the analytical laboratory performing the tests.

\*Field filtered

<sup>a</sup>W = water<sup>b</sup>All containers will be sealed with Teflon®-lined screw caps.<sup>c</sup>All samples will be stored promptly at 4°C in an insulated chest.<sup>d</sup>Holding times are from the time of sample collection.

TABLE 4

Groundwater Screening Levels  
Revised Sitewide Groundwater Performance Monitoring Plan  
Bayer CropScience Institute Facility  
Institute, West Virginia

Analyte Name	Applies to Main Chemical Plant Area	Applies to WWTU Area	Group	USEPA MCLs or Tap Water RSLs (µg/L) <sup>1</sup>	Site-Specific GWSLs or BTAG ESLs (µg/L)	Laboratory Reporting Limit <sup>2</sup>	Basis of Site-Specific GWSLs or BTAG ESL
1,1,2,2-Tetrachloroethane	x		VOC	<b>0.076</b>	610	1	BTAG ESL
1,1,2-Trichloroethane	x		VOC	5*	1200	1	BTAG ESL
1,1-Dichloroethane	x		VOC	2.7	47	1	Site-Specific GWSL (Ecological)
1,1-Dichloroethene	x		VOC	7*	25	1	BTAG ESL
1,2,4-Trimethylbenzene	x		VOC	1.5	33	1	BTAG ESL
1,2-Dichloroethane	x		VOC	5*	100	1	Site-Specific GWSL (Ecological)
1,2-Dichloropropane	x		VOC	5*	--	1	--
1,3,5-Trimethylbenzene	x		VOC	12	71	0.4	BTAG ESL
1,3-Dichlorobenzene	x		VOC	75***	150	0.5	BTAG ESL
1,4-Dichlorobenzene	x		VOC	75*	26	1	BTAG ESL
2-Butanone	x		VOC	560	14000	5	BTAG ESL
2-Hexanone	x		VOC	<b>3.8</b>	99	5	BTAG ESL
4-Methyl-2-Pentanone	x		VOC	120	170	5	BTAG ESL
Acetone	x		VOC	1400	1500	5	BTAG ESL
Benzene	x	x	VOC	5*	130	1	Site-Specific GWSL (Ecological)
Bromodichloromethane	x		VOC	80**	--	1	--
Bromomethane	x		VOC	<b>0.75</b>	--	1	--
Carbon Disulfide	x		VOC	81	105	1	Site-Specific GWSL (Ecological)
Carbon tetrachloride	x		VOC	5*	13.3	1	BTAG ESL
Chlorobenzene	x		VOC	100*	64	1	Site-Specific GWSL (Ecological)
Chloroform	x		VOC	80**	3400	1	Site-Specific GWSL (Ecological)
Chloromethane	x		VOC	19	--	1	--
cis-1,2-Dichloroethene	x		VOC	70*	--	1	--
Dibromochloromethane	x		VOC	80**	--	0.4	--
Dichlorodifluoromethane	x		VOC	20	7522	1	Site-Specific GWSL (Ecological)
Diethyl ether	x		VOC	390	--	10	--
Ethylbenzene	x		VOC	700*	7.3	1	Site-Specific GWSL (Ecological)
Methylene chloride	x		VOC	5*	98.1	1	BTAG ESL
Styrene	x		VOC	100*	72	1	Site-Specific GWSL (Ecological)
Tetrachloroethene	x	x	VOC	5*	111	1	BTAG ESL
Toluene	x		VOC	1000*	9.8	1	Site-Specific GWSL (Ecological)
trans-1,2-Dichloroethene	x		VOC	100*	--	1	--
Trichloroethene	x	x	VOC	5*	21	1	BTAG ESL
Trichlorofluoromethane	x	x	VOC	110	5008	1	Site-Specific GWSL (Ecological)
Vinyl chloride	x	x	VOC	2*	930	1	Site-Specific GWSL (Ecological)
Xylenes	x		VOC	10000*	67	1	Site-Specific GWSL (Ecological)
1,4-Dioxane	x	x	SVOC	<b>0.78</b>	22740	1	Site-Specific GWSL (Ecological)
2-Methylnaphthalene	x		SVOC	3.6	72.2	0.5	Site-Specific GWSL (Ecological)
Benzo(b)fluoranthene	x		SVOC	<b>0.034</b>	--	0.5	--
bis(2-Chloroethyl)ether	x	x	SVOC	<b>0.014</b>	1892	0.5	Site-Specific GWSL (Human Health)
bis(2-Chloroisopropyl)ether	x		SVOC	<b>0.36</b>	297	0.5	Site-Specific GWSL (Ecological)
bis(2-Ethylhexyl)phthalate	x		SVOC	6*	16	5	BTAG ESL
Hexachloroethane	x		SVOC	0.69	12	0.5	BTAG ESL
Isophorone	x		SVOC	78	9230	0.5	Site-Specific GWSL (Ecological)
Naphthalene	x		SVOC	<b>0.14</b>	193	0.5	Site-Specific GWSL (Ecological)
Phenol	x		SVOC	580	2560	0.5	Site-Specific GWSL (Ecological)
Beryllium, dissolved		x	Metal	4*	<b>0.66</b>	2	Site-Specific GWSL (Ecological)
Cadmium, dissolved		x	Metal	5*	<b>0.246</b>	0.6	Site-Specific GWSL (Ecological)
Cobalt, dissolved		x	Metal	<b>0.6</b>	23	1	Site-Specific GWSL (Ecological)
Lead, dissolved		x	Metal	15	2.52	1	Site-Specific GWSL (Ecological)
Manganese, dissolved		x	Metal	43	120	2	Site-Specific GWSL (Ecological)

**Notes:**

COC = constituent of concern

USEPA = U.S. Environmental

Protection Agency

MCL = maximum contaminant level

RSL = Regional Screening Level

GWSL = groundwater screening level

VOC = volatile organic compound

SVOC = semivolatile organic compound

-- = no screening level available

µg/L = micrograms per liter

BTAG = USEPA Biological Technical Assistance Group Region 3 ecological screening level (ESL; USEPA 2006)

Site-Specific GWSL (Ecological) = the ecological based site-specific GWSL protective of Kanawha River exposure pathways (CH2M HILL 2012b)

Site-Specific GWSL (Human Health) = the human health based site-specific GWSL protective of Kanawha River exposure pathways (CH2M HILL 2012b)

<sup>1</sup> The listed screening levels are the MCLs (USEPA 2009) or the USEPA tap water RSLs (USEPA 2014), if a constituent does not have an MCL.

\* Value is the USEPA MCL.

\*\* The listed MCL (80 µg/L) is applied to the sum of four trihalomethanes (bromodichloromethane, bromoform, dibromochloromethane, and chloroform) as an annual average as discussed in the National Primary Drinking Water Standards (USEPA 2009) available at: <http://water.epa.gov/drink/contaminants/index.cfm#List>. Only three of the trihalomethanes are included in this revised work plan.

\*\*\* The MCL for 1,4-dichlorobenzene was used for the screening level listed for 1,3-dichlorobenzene. The compound 1,4-dichlorobenzene was identified as a surrogate for 1,3-dichlorobenzene in the CCR (CH2M HILL 2009).

<sup>2</sup> The laboratory reporting limits are as of October 31, 2014 (Microbac Laboratories, Marietta, Ohio).

Screening levels that are bolded and italicized indicate they cannot be quantified within current laboratory reporting limits; although the laboratory reporting limit is slightly above some of the screening levels, the objectives of the PMP will still be achieved

TABLE 5

Main Chemical Plant Other Targeted COCs - Applicable Wells to Track Concentration Trends

*Revised Sitewide Groundwater Performance Monitoring Plan**Institute, West Virginia*

Well ID	Dichloro- difluoro- methane	Trichloro- fluoro- methane	1,4-Dioxane	Bis(2- chloroethyl) ether	Bis(2- chloroiso- propyl) ether	Phenol
ENBN-I4		X				
MW-102						X
TW-45	X					
TW-52A				X	X	
TW-52B				X	X	
TW-54B		X				
TW-56	X	X				
TW-57	X	X				
TW-60A			X			
TW-60B			X			
TW-63A						X
TW-63B						X
TW-65B			X			

**Notes:**

COC = constituent of concern

## Figures

---





Figure 1  
 Facility Location Map  
 Revised Sitewide Groundwater Performance Monitoring Plan  
 Bayer CropScience Institute Facility  
 Institute, West Virginia





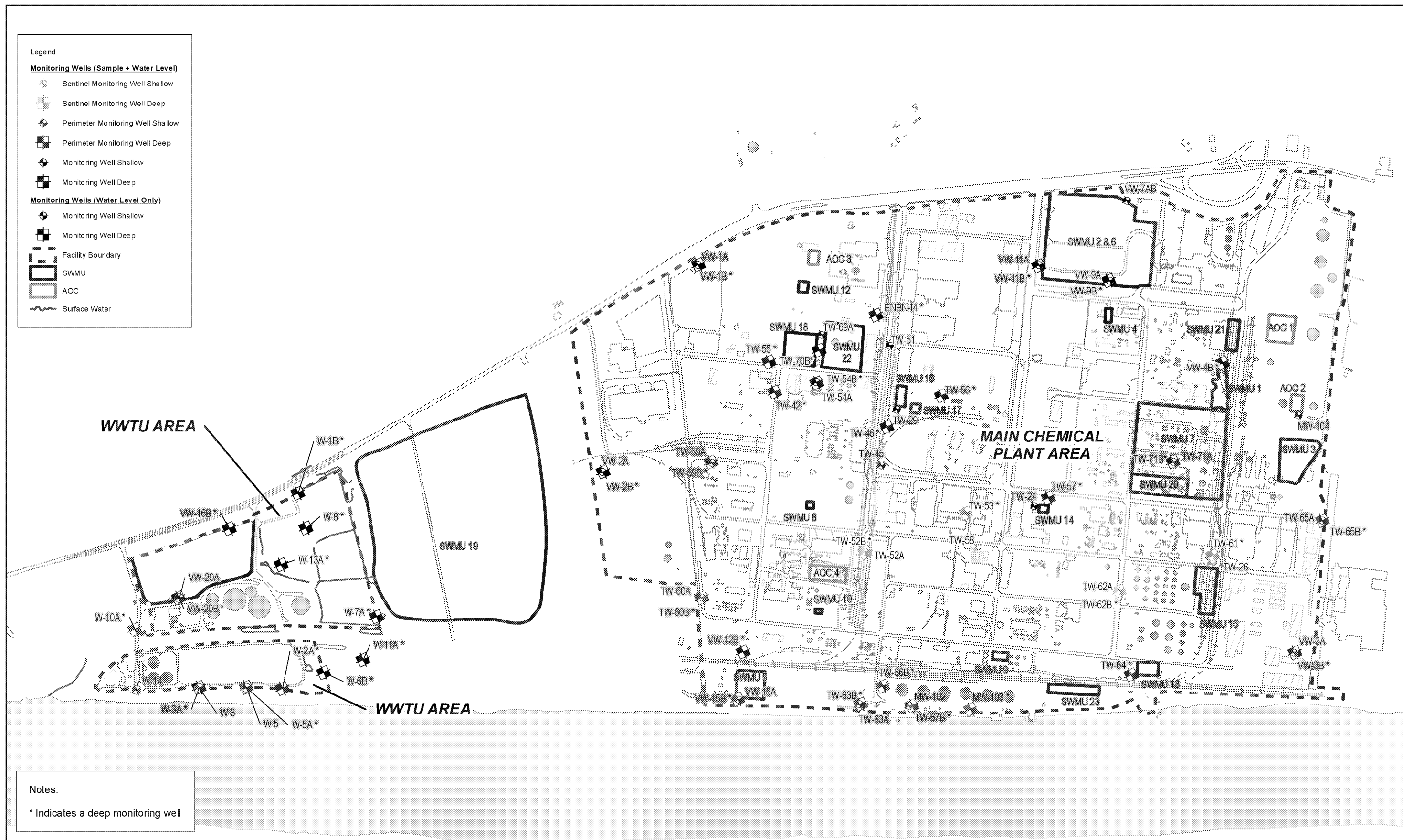
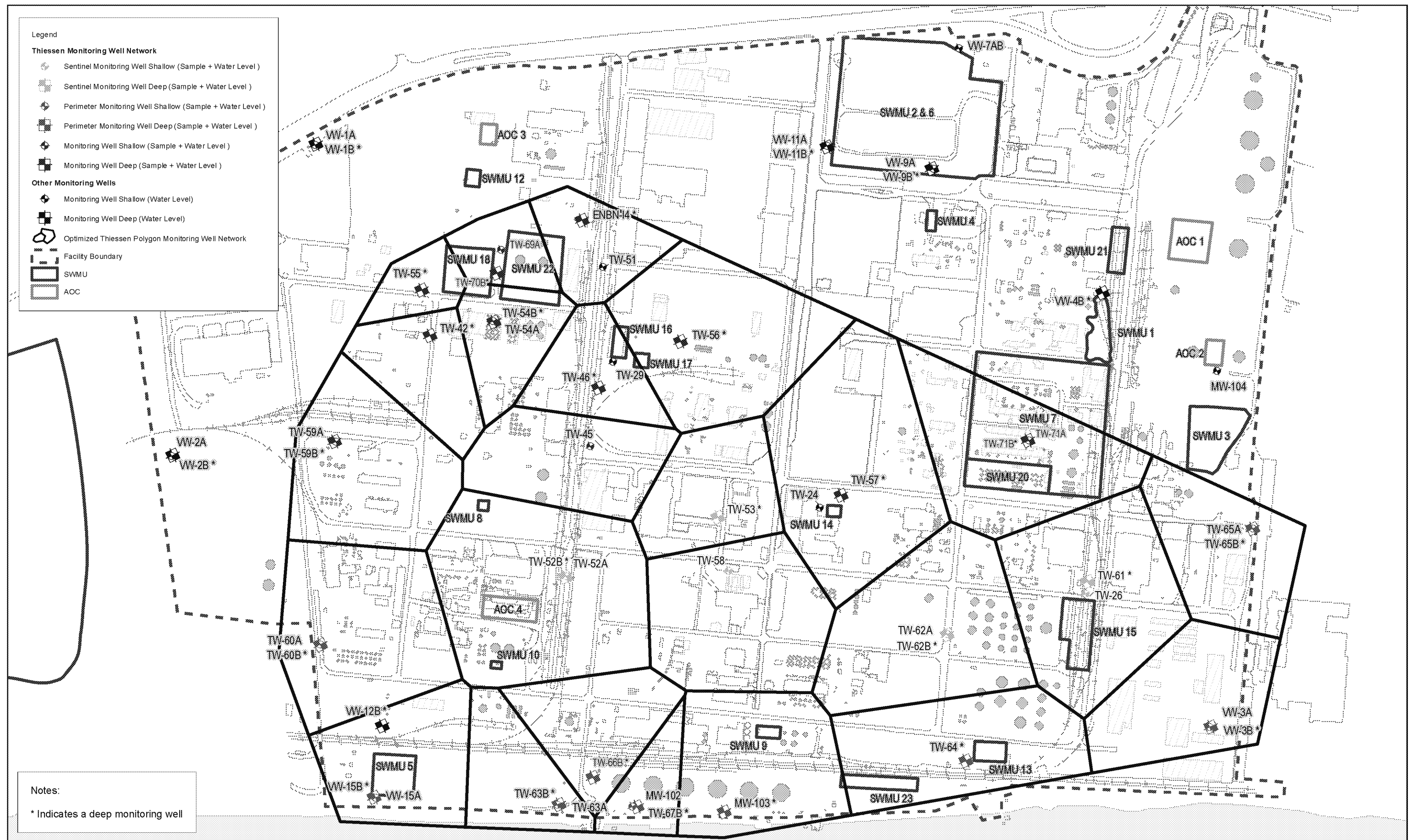


Figure 2  
Groundwater Monitoring Network  
Revised Sitewide Groundwater Performance Monitoring Plan  
Bayer CropScience Institute Facility  
Institute, West Virginia







**Appendix A**  
**Standard Operating Procedures**

---



# Water-Level Measurements

---

## Purpose and Scope

The purpose of this standard operating procedure (SOP) is to provide a guideline for the measurement of the depth to groundwater, and where present, a second phase of liquid (e.g., light nonaqueous phase liquid [LNAPL] or dense nonaqueous phase liquid [DNAPL]), in piezometers, monitoring wells, and on staff gages in surface water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuous recording loggers.

## Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with minimum increments of 0.01 foot; or
- When nonaqueous phase liquids are present, interface probe (Solinst® Model 122 Interface Meter or equivalent).

## Procedures and Guidelines

### Section 1 – Water-Level Only

Ensure the instrument has been decontaminated prior to its first use. Verify that the unit is turned on and functioning properly. *Slowly* lower the probe into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from the reference point on the piezometer or well riser, typically marked by a surveyor on the top of the riser. If no reference is clearly visible, measure the depth to water from the northern edge of the riser. If access to the top of the riser is difficult, sight across the top of the locking casing adjacent to the measuring point and note this in the field logbook.

Holding the tape so it freely dangles in the well/piezometer and does not rest or bend against the casing, measure the distance from the reference point to the closest interval marker on the tape and record the water-level reading and time of the reading in the logbook. Water levels should be measured to the nearest 0.01 foot.

### Section 2 – NAPL Present

If LNAPL or DNAPL is suspected in a piezometer or well, the thickness of the nonaqueous phase liquid (NAPL) should be determined using an interface probe (e.g., Solinst® Model 122 Interface Meter). The depth to water can also be determined with an interface probe; however, a water-level meter should not be used in a piezometer or well where product is suspected or present.

Record depth to NAPL in the same manner as recording depth to water. When lowering the probe, a constant sound emitted from the device indicates the presence of free product and an alternating on/off beep sound is emitted when water is encountered.

Measure the distance from the reference point to the closest interval marker on the tape for both the depth at which the constant sounds begins (depth to product) and the alternating beep occurs (depth to water), and record in the logbook along with the time of the measurements. Water levels and product thickness should be measured to the nearest 0.01 foot. NAPL may occur atop the water column (LNAPLs), in the middle of the column (NAPL), and at the bottom of the water column (DNAPL).

Report all detections of NAPL to the project team the day of the observation and before any sampling is completed.

## **Attachments**

None.

## **Key Checks**

Before each use, verify that the battery is charged by pressing the test button on the water-level meter. Verify that the unit is operating correctly by testing the probe in distilled water (or tap water). Leave the unit turned off when not in use. Decontaminate equipment using a mixture ofalconox/liquidnox and deionized water between each location to reduce cross contamination. Where possible, ensure measurements are collected in order from the least to the most contaminated wells to reduce cross-contamination.



# Field Measurement of Dissolved Oxygen

---

## Purpose

The purpose of this standard operating procedure (SOP) is to provide a general guideline for field measurement of dissolved oxygen (DO) in water samples.

## Scope and Applicability

This SOP provides information on equipment, materials, and procedures used for standard field DO determination in water samples. Calibration records will be recorded on calibration sheets or in the field logbook. Calibration information to be recorded are the instrument manufacturer, model number, serial number, and calibration media lot number and date of manufacture.

These procedures are to be used unless otherwise specified by the instrument manufacturer.

## Equipment/Materials

- DO meter
- DO probe
- Potassium chloride (KCl) probe refill solution
- Spare probe membranes
- Spray bottle with deionized water

## Procedures/Guidelines

### Procedure

1. Before going into the field:
  - Check batteries;
  - Perform calibration; and
  - Check probe membrane.
2. Record instrument make, model, and serial number in the logbook or data form.
3. Calibrate meter using calibration procedure per manufacturer's recommendation and a duplicate reading every 10 samples.
4. Rinse probe with deionized water.
5. Immerse probe in sample. Record DO reading in the logbook or data form, and record the results once the readings have stabilized.

6. Decontaminate the probe and the beaker, and then cover to protect them from contamination.

## **General**

Measurement of DO is temperature dependent. Therefore, temperature correction must be accurate when calibrating.

Following the field measurements:

- Record any problems.
- Compare with previous data and note any large variances.
- Clean all dirt off the meter and from inside the case.
- Store probe in calibration container with wet towel/ sponge.

Accuracy and precision are dependent on the instrument used. Refer to manufacturer's manual.

## **Key Checks/Items**

- Check batteries;
- Check the membrane;
- Calibrate; and
- Decontaminate and cover the probe.

# Field Measurements of pH

---

## Purpose

The purpose of this standard operating procedure (SOP) is to provide a general guideline for field measurement of pH in water samples.

## Scope

Standard field pH determination techniques for use on surface water and groundwater samples. Calibration records will be recorded on calibration sheets or in the field logbook. Calibration information to be recorded are the instrument manufacturer, model number, serial number, and calibration media lot number, and date of manufacture.

These procedures in this SOP are to be used unless otherwise specified by the instrument manufacturer.

## Equipment/Materials

- pH buffer solution for pH 4, 7, and 10
- Deionized water in squirt bottle
- pH meter
- Combination electrodes
- Beakers
- Solution of HCl
- Glassware that has been washed with soap and water, rinsed twice with hot water, and rinsed twice with deionized water

## Procedures/Guidelines

### Procedure

1. Before going into the field:
  - Check batteries;
  - Do a quick calibration at pH 7 and 4 to check electrode; and
  - Obtain fresh standard solutions.
2. Calibrate meter using calibration procedure.
3. Rinse electrode with deionized water between samples.
4. Immerse electrode in sample solution. Record pH reading.

5. Recheck calibration with pH 7 buffer solution after every five samples.

Decontaminate pH meter before use at each sample location. Rinse probe with distilled water before storage each day. Check meter for battery charge and physical damage each day. Store meter and pH buffer solution in a cool, dry environment.

## General

1. When calibrating meter, use pH buffers 4 and 7 for samples with pH < 8, and buffers 7 and 10 for samples with pH > 8. If meter will not read pH 4 or 10, there may be a problem with the electrode.
2. Measurement of pH is temperature dependent. Therefore, temperatures of buffers and samples should be within about 2°C. For refrigerated or cool samples, use refrigerated buffers to calibrate pH meter.
3. Weak organic and inorganic salts, oil, and grease interfere with pH measurements. If oil or grease are visible, note it on the data sheet. Clean electrode with soap and water, and rinse with a 10 percent solution of HCl. Then recalibrate meter.
4. Following field measurements:
  - Report any problems;
  - Compare with previous data;
  - Clean all dirt off of the meter and from inside the case; and
  - Store electrode in pH 4 buffer solution.
5. Accuracy and precision are dependent on the instrument used. Refer to the manufacturer's manual.

## Attachments

None.

## Key Checks/Items

- Check batteries; and
- Calibrate.

## Preventive Maintenance

- Refer to the operation manual for recommended maintenance.
- Check batteries. Have a replacement set on hand.

# Field Measurement of Specific Conductivity and Temperature of Water

---

## Purpose

The purpose of the standard operating procedure (SOP) is to provide a general guideline for the field measurement of conductivity and temperature.

## Scope

Field instruments must be calibrated daily before beginning sampling activities. The methods and frequencies of calibration for the instruments used for each field activity are described in this SOP. Calibration records will be recorded on calibration sheets or in the field logbook. Calibration information to be recorded are the instrument manufacturer, model number, serial number, and calibration media lot number, and date of manufacture.

These procedures in this SOP are to be used unless otherwise specified by the instrument manufacturer.

## Equipment/Materials

- Reagents – Distilled water in squirt bottle and standard potassium chloride (KCl) solution
- Reagent Preparation:
  - Stock KCl solution (1.00 N): Dissolve 74.555 g KCl in distilled water and dilute to 1,000 mL in a volumetric flask.
  - Standard KCl solution (0.01 N): Dilute 10.0 mL of stock 1.00 N KCl solution to 1,000 mL with distilled water using a volumetric pipet and flask.
- Conductivity meter and electrodes
- Beakers or jars, plastic or glass
- Spare size D, alkaline batteries

## Procedures/Guidelines

### Groundwater

- Detection limit = 1  $\mu\text{mho}/\text{cm}$  @ 25°C; range = 0.1 to 100,000  $\mu\text{mho}/\text{cm}$
- 10  $\mu\text{mhos}/\text{cm}$  = 1 mS/m

## Calibration Check

Check instrument calibration before initial daily use and at least once every 4 hours or every five samples, whichever is less. Check instrument with standard solution. Deviations should be noted in the field logbook.

1. Turn on instrument.
2. Hit mode key until “°C” symbol is flashing to indicate temperature-corrected results (conductivity units should be  $\mu\text{mhos}$ ).
3. Read standard and note results.
4. Rinse probe with deionized water.
5. Run sample and record results.
6. Rinse with deionized water when done.

Decontaminate conductivity meter before use at each sample location. Rinse probe with distilled water before storage each day. Check meter for battery charge and physical damage each day. Store meter and conductivity standard in a cool, dry environment.

## Operation Procedure

1. Perform calibration at the beginning and end of the day.
2. Switch mode to temperature. Allow time for the probe temperature to come to equilibrium with that of the water before reading. Read the temperature on the bottom scale of the meter in degrees Celsius (°C).
3. Switch mode to X100. If the reading is below 50 on the 0 to 500 range (5.0 on the 0 to 50 mS/m range), switch to X10. If the reading is still below 50 (5.0 mS/m), switch to the X1 scale. Read the meter scale and multiply the reading by the mode factor. The answer is expressed in Fohms/cm. Measurements are not temperature-compensated.
4. When measuring on the X100 and X10 scales, depress the CELL TEST button. The meter reading should fall less than 2 percent; if greater, the probe is fouled and the measurement is in error. Clean the probe and remeasure.

## Operating Suggestions

- Obstructions near the probe can disturb readings.
- When the calibration test indicates low readings, the probable cause is dirty electrodes. Hard water deposits, oil, and organic matter are the most likely contaminants.
- Caution: Do not touch the electrodes inside the probe. The plating material is soft and can be scraped off.
- If cleaning does not restore the probe performance, replatinizing may be required. Always rinse the probe thoroughly in tap water, then in distilled or deionized water after cleaning and before storage. Note that it is best to store conductivity cells in

deionized water. Collect rinsate water for storage pursuant to the Waste Management Plan.

- Most problems in obtaining good records with monitoring equipment are related to electrode fouling and inadequate sample circulation.
- Decontaminate conductivity meter before use at each sample location. Rinse probe with distilled water before storage each day. Check meter for battery charge and physical damage each day. Store meter and conductivity standard in a cool, dry environment.
- Water temperature readings can be taken using the conductivity meter. Switch from conductivity mode to temperature mode and record the reading in the field notebook.

## Attachments

None.

## Key Checks/Items

- Document any deviations from above procedure;
- Check battery;
- Check calibration;
- Clean probe with deionized water when done; and
- When reading results, note sensitivity settings.

## Preventive Maintenance

- Refer to operations manual for recommended maintenance.
- Check batteries. Have a replacement set on hand.





# Low-Flow Groundwater Sampling from Monitoring Wells

---

## Purpose and Scope

This standard operating procedure (SOP) presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

## Equipment and Materials

- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe.
- Meters to monitor water quality parameters (e.g., pH, specific conductance, turbidity, dissolved oxygen [DO], oxidation-reduction potential [ORP], and temperature) (e.g., Horiba® U-22 or similar).
- Water-level indicator.
- Adjustable-rate, positive-displacement pump, submersible, or peristaltic pump.
- Generator.
- Disposable polyethylene tubing.
- Plastic sheeting.
- Well construction information.
- Calibrated bucket or other container and watch with second indicator to determine flow rate.
- Sample containers.
- Shipping supplies (labels, coolers, and ice).
- Field logbook.

## Procedures and Guidelines

### A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.

2. Instruments are calibrated according to manufacturer's instructions and information such as make/model and calibration and use specifications are recorded in the field logbook.
3. The well number, site, date, and condition are recorded in the field logbook.
4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not allow any downhole equipment to touch the ground.
5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP No. 6, *Field Sampling Equipment Decontamination*.
6. Water-level measurements are collected in accordance with SOP No. 1, *Water Level Measurements*. **Do not measure the depth to the bottom of the well at this time;** this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth-to-bottom information from the well installation log.
7. Attach and secure the polyethylene tubing to the low-flow pump. *Slowly* lower the pump into the well such that the pump intake is at least 2 feet above the bottom of the well to avoid mobilization of any sediment present in the bottom. Preferably, the pump intake should be set in the middle of the screen.
8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.
9. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates can be increased for more transmissive formations. Record the initial water quality parameters in the field logbook.
10. The water level should be monitored during purging and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.5 feet). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1 to 0.2 liters per minute) to avoid affecting well drawdown.
11. During purging, the water quality parameters are measured frequently (every 3 to 5 minutes) until the parameters have stabilized. Water quality parameters are considered stabilized when measurements meet the following criteria:
  - pH: within 10 percent;
  - Specific conductance: within 3 percent;
  - DO: within 10 percent;
  - Turbidity: within 10 percent or as low as practicable given sampling conditions; and

- ORP: within 10 millivolts (mV).

## B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Typically, each bottle will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the logbook:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity);
2. Sample source and source description;
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements; and
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number).

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 milliliters (ml) per minute when sampling volatile organic compounds (VOCs).
3. Samples for analysis for VOCs should be collected first, if such samples are required.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.
5. The bottle is capped and then labeled clearly and carefully.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

## C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return to the well periodically, but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. It may not be possible to prevent drawdown in the well if the water-bearing unit has sufficiently low permeability. If the water level was in the screen to start with, this is not a concern because no stagnant water is present in the riser above the screen.

If the water level in the well is in the riser above the screen at the beginning of purging, then be sure to pump out sufficient volume from the well to remove the volume of water in the riser above the screen. For a 2-inch-diameter well, each foot of riser contains 0.163 gallons; for a 4-inch riser, each foot of riser contains 0.653 gallons; for a 6-inch riser, each foot of riser contains 1.47 gallons.

Alternatively, the water in the riser above the screen can be removed by lowering the pump into the well until the pump intake is just below the water level, starting the pump, running it at a low rate, and slowly lowering the pump as the water level in the riser declines. This approach can be terminated when the water level reaches the top of the screen, at which time the stagnant water in the riser has been removed. This approach, however, may not be a practical for dedicated sampling equipment. As with typical low-flow sampling, the flow rate should be kept as low as practicable.

3. There may be circumstances where a positive-displacement or submersible pump cannot be used. An example is at isolated, hard-to-reach locations where the required power supply cannot be provided. In this case, a peristaltic pump may be used. Samples can be collected by the procedures described above for all but those for VOC analysis. The water to be placed in the vials for VOC analysis should not be run through the peristaltic pump, but instead should be collected as follows:
  - Stop the pump when it is time to collect the VOC sample.
  - Disconnect the tubing upstream from the pump (a connector must be installed in the line in order to do this).
  - Remove the tubing from the well, making sure to hold one finger over the end of the tubing to keep the water in the tubing. Be sure that the tubing does not contact other than clean surfaces.
  - Place the end of the tubing that was in the well into each VOC vial and fill the vial by removing your finger from the other end of the tubing.
  - Once the vials are filled, return the tubing to the well and collect any other samples required.
4. Non-dedicated sampling equipment is removed from the well, cleaned, and decontaminated in accordance with SOP No. 6, *Decontamination of Personnel and Equipment*. Disposable polyethylene tubing is disposed of with contaminated personal protective equipment (PPE).

## Attachments

White paper on reasons and rationale for low-flow sampling.

## Key Checks and Preventative Maintenance

- Minimize drawdown in the well as much as possible (preferably no more than 0.5 to 1 foot) so that natural groundwater flow conditions are maintained as closely as feasible.
- Avoid stirring up of sediment in the well so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Avoid pump overheating to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to, the following:
  - Inspect sampling pump regularly and replace as warranted;
  - Inspect quick-connects regularly and replace as warranted; and
  - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts.



# Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

---

## White Paper on Low-Flow Sampling

The U.S. Environmental Protection Agency (USEPA) recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater flow system around the well experiences minimal disturbance. Some disturbance will inevitably occur as a result of causing groundwater to flow to the well in a radial fashion, which, otherwise, would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample (as well as its effect on the dissolved oxygen [DO] levels), which will then be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds (VOCs) due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, DO content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, semivolatile organic compounds (SVOCs), and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can add unreasonably to the measured concentration of SVOCs and other organic compounds.

The standard operating procedure (SOP) for low-flow sampling has been modified recently and should be consulted for additional information and ways of dealing with wells in which the water level cannot be maintained at a constant level.



# Field Sampling Equipment Decontamination

---

## Purpose

The purpose of this standard operating procedure (SOP) is to provide general guidelines for decontamination of soil sampling equipment, monitoring equipment, and sample containers used in potentially contaminated environments.

## Equipment/Materials

- Laboratory-grade, analyte-free, deionized or distilled water (for equipment blank collection).
- Potable water.
- Deionized or distilled water (for final pump rinsing).
- Alconox®, Liquinox®, or other phosphate-free detergent and water solution.
- Two or three plastic pails or tubs for detergent and water (5-gallon bucket).
- Scrub brushes and/or pipe-cleaning brushes.
- One or two squirt/spray bottles.
- Plastic bags.
- Plastic sheets.
- Pliers, O-ring pullers, large flat-head screwdriver (short handle), large coin.
- Paper towels.
- U.S. Department of Transportation (DOT)-approved 55-gallon drum for disposal of waste.

## Procedures/Guidelines

### Sampling Equipment Decontamination

All soil, surface water, and sediment sampling equipment not to be steam cleaned (e.g., drilling equipment) will be decontaminated by personnel wearing disposable latex or vinyl gloves using the following procedure:

1. Remove loose soil and gross contamination.
2. Rinse with potable water.
3. Wash all equipment surfaces that contacted the potentially contaminated soil or water with a detergent solution (potable water and Alconox®, Liquinox®, etc.), using a brush as needed to remove particulate matter and surface film.

4. Rinse with potable water.
5. Rinse with deionized or distilled water and air dry.
6. Wrap the equipment with aluminum foil, if appropriate, to prevent contamination if the equipment is to be stored or transported.
7. Collect and dispose of all decontamination fluid in a DOT-approved 55-gallon drum or as otherwise specified in the work plan, project instructions, and the Waste Management Plan.

## **Monsoon Pump Decontamination**

Monsoon pumps and sections of cable that come into contact with the well and groundwater during well development, purging, and sampling must be decontaminated before using the pump and cable in a subsequent well. The pump and cable will be decontaminated following the steps below:

1. When pulling the pump out of the well, do not roll the pump cable onto the reel so as not to contaminate the other section of the cable that has not come in contact with the groundwater; instead, coil the pump cable on the plastic sheet that is laid around the well during sampling. In addition, wipe the cable as it is pulled out of the well using a paper towel wet with detergent solution.
2. Remove the outer housing of the pump from the motor.
3. Scrub the pump motor and the inside of the pump motor housing with detergent solution. Re-assemble for use in Step 4.
4. Set up three 5-gallon buckets as follows:
  - Bucket A distilled/potable water and detergent (Liquinox®, Alconox®, etc.) solution;
  - Bucket B distilled/potable water; and
  - Bucket C distilled/potable water.

The amount of liquid in each bucket should be enough to completely submerge the pump and the section of the cable that came in contact with the groundwater.

5. Immerse the pump and cable in Bucket A. Run the pump in Bucket A for 1 minute while capturing the discharge into the investigation-derived waste (IDW) drum. After this first minute, the Alconox® solution can be circulated in Bucket A for another 3 to 4 minutes. The pump cable will be scrubbed with a decontamination brush in Bucket A before transferring the cable to Bucket B with the pump.
6. Next, transfer the pump to the second bucket (Bucket B). Run the pump for 1 minute discharging the water into the IDW drum. Then, run the pump with the water being re-circulated for 3 to 4 minutes. Make sure the cable is also placed in this bucket. The cable should be wiped dry and allowed to air dry.
7. Transfer the pump, without the cable, to Bucket C. Run the pump for 1 minute discharging the water into the IDW drum. Then run the pump in Bucket C re-circulating the water for 3 to 4 minutes. Wipe down and allow to air dry.

8. If the pump is not going to be used immediately, it should be wrapped with aluminum foil and stored along with the reel in a double-plastic bag until it is ready for use.

To minimize the amount of IDW generated from the pump decontamination process, the decontamination water can be rotated as described below:

- Water in bucket A is discarded after a cycle of decontamination.
- Water in Bucket B becomes the soap solution for Bucket A for the next cycle.
- Water in Bucket C becomes the first rinse water (Bucket B) for the next cycle.
- Bucket C is then filled with fresh potable water.

### Bladder Pump Decontamination

Bladder pumps used for well development, purging, and sampling must be decontaminated before using the pump in a subsequent well. The most effective decontamination process is to completely disassemble the pump, clean the stainless steel and non-disposable parts, and replace the Teflon® bladder and O-rings after each use. However, complete disassembly of the pump will only occur **after 20 samples** have been collected with the pump **or when the pump is used at different facilities (whichever is sooner)**. **The bladder will only be replaced if it shows signs of significant wear or discoloration.**

### Non-Disassembly Decontamination Procedure

The pump will be decontaminated following the steps below:

1. When pulling the pump out of the well, make sure that the disposable tubing and rope are placed on the plastic sheet that is laid around the well during sampling. Remove the tubing from the top of the pump and replace with shorter sections of tubing that is long enough to reach the IDW drum. The tubing and rope will be disposed of in the proper 55-gallon drum or trash receptacle onsite. The tubing and rope will be replaced for the subsequent well.
2. Remove any loose material and gross contamination from the outer casing of the pump.
3. Rinse with potable water.
4. Set up three 5-gallon buckets as follows:
  - Bucket A distilled/potable water and detergent (Liquinox®, Alconox®, etc.) solution;
  - Bucket B distilled/potable water; and
  - Bucket C distilled/potable water.

The amount of liquid in each bucket should be sufficient to completely submerge the pump.

5. Immerse the pump in Bucket A. Run the pump in Bucket A for 1 minute while capturing the discharge into the IDW drum. After this first minute, the Alconox® solution can be circulated in Bucket A for another 3 to 4 minutes.
6. Next, transfer the pump to the second bucket (Bucket B). Run the pump for 1 minute discharging the water into the IDW drum. Then run the pump with the water being re-circulated for 3-4 minutes.

7. Transfer the pump to Bucket C. Run the pump for 1 minute discharging the water into the IDW drum. Then run the pump in Bucket C re-circulating the water for 3 to 4 minutes. Wipe down and allow to air dry.
8. If the pump is not going to be used immediately, the decontaminated pump should be wrapped with aluminum foil to prevent contamination of the equipment.

To minimize the amount of IDW generated from the pump decontamination processes, the decontamination water can be rotated as described below.

- Water in bucket A is discarded after a cycle of decontamination.
- Water in Bucket B becomes the soap solution for Bucket A for the next cycle.
- Water in Bucket C becomes the first rinse water (Bucket B) for the next cycle. Fresh potable water is then put in bucket C.

**Equipment Blanks:** Rinse the pump and cable with laboratory-provided deionized water before collecting equipment from the pump and cable. The equipment blank sample should then be collected by pumping laboratory-grade deionized water into the sample container.

### **Complete Disassembly Decontamination Procedure**

For complete disassembly of the pump, the pump will be decontaminated following the steps below:

1. When pulling the pump out of the well, make sure that the disposable tubing and rope are placed on the plastic sheet that is laid around the well during sampling. Remove the tubing from the top of the pump. The tubing and rope will be disposed of in the proper 55-gallon drum or trash receptacle onsite. The tubing and rope will be replaced for the subsequent well.
2. Remove any loose material and gross contamination from the outer casing of the pump.
3. Rinse with potable water.
4. Set up three 5-gallon buckets as follows:
  - Bucket A distilled/potable water and detergent (Liquinox®, Alconox®, etc.) solution;
  - Bucket B distilled/potable water; and
  - Bucket C distilled/potable water.

The amount of liquid in each bucket should be enough to completely submerge the pump.

5. Using adjustable channel-locking pliers, remove the threaded top and bottom caps from the housing tube.
6. Remove any O-rings from the caps, dispose of the O-rings, and place the top and bottom caps in the decontamination bucket containing a water/detergent solution. NOTE: This step does not need to be completed on every well. Replace O-rings only if they are showing signs of fatigue, have been used to collect 20 samples, or if the pump will be used at a different facility (whichever is sooner).

7. Stand the pump housing upright on a firm surface and free the Teflon® bladder assembly from inside of the pump housing by pushing it down on the firm surface.
8. Remove the collars holding the Teflon® bladder, being careful not to lose the stainless steel check balls in either end of the bladder assembly. Some models may only have one check ball.
9. Remove and clean the O-rings and Teflon® bladder assembly. NOTE: Replace any O-rings or Teflon® bladders that show signs of significant wear or discoloration.
10. Place the collars, screen, and inlet tube in the decontamination bucket.
11. Using a mixture of potable water and detergent solution, thoroughly clean the inside of the inlet tube using the pipe-cleaning brushes. Using a sponge or brush, thoroughly clean the outside of all the pump's stainless steel (and non-disposable) parts as well as the inside of the pump body, which covers the bladder. Clean the O-rings and bladders (unless they are being replaced).
12. Transfer the washed parts to a clean water rinse bucket.
13. Remove the cleaned parts from the clean water rinse bucket.
14. Place the parts on a clean paper towel to allow for drying after the final rinse is completed.
15. Reassemble the pump.
16. If the pump is going to be stored or transported, the decontaminated pump should be wrapped with aluminum foil to prevent contamination of the equipment.

### **Decontamination of Water-Level Indicator**

The water-level indicator used to measure depth to water and depth to bottom in monitoring wells and piezometers must be decontaminated between each well. To decontaminate the water-level indicator, follow the steps below:

1. When pulling the water-level indicator from the well, do not roll up the tape in the reel so as not to contaminate the section of the tape that has not come in contact with the groundwater. Instead, pull the tape and probe directly into a bucket that will be used for the decontamination process. In addition, wipe the tape as it is being pulled out using with a paper towel wet with detergent solution.
2. Immerse the section of the tape and probe that came in contact with the groundwater in a 5-gallon bucket filled with soapy solution. Wash the tape and probe in the bucket with a decontamination brush.
3. Next, transfer the tape and probe to another 5-gallon bucket filled with potable water. Rinse the tape and probe in the second bucket. Wipe the tape and probe dry with paper towel before rolling the tape onto the reel of the water-level meter
4. If the water-level meter is not going to be used immediately in another well, wrap the meter in a double-plastic bag for storage.

## Sample Container Decontamination

The outer surface of sample containers filled in the field must be decontaminated before being packed for shipment or handled by personnel without dermal hand protection as follows:

1. Wipe container with a paper towel dampened with detergent solution after the containers have been sealed.
2. Wipe container with a paper towel dampened with potable water.
3. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

## Key Checks/Items

- Clean with solutions of detergent, and deionized or distilled water.
- Drum all contaminated rinsate and materials as specified in project instructions and the Waste Management Plan.
- Decontaminate sample bottles before relinquishing them to anyone.
- Document any deviations from above procedure.